

FLEXIBLE DISPLAY DEVICE AND METHOD FOR MANUFACTURING FLEXIBLE DISPLAY DEVICE

TECHNICAL FIELD

[0001] The present invention relates to an electronic device having flexibility (flexible electronic device), or a display device having flexibility which is for use in e.g. an electronic book, an electronic notebook, an electronic newspaper, digital signage, or the like.

BACKGROUND ART

[0002] A wide variety of electronic devices and display devices have hitherto been developed, among which is a flexible electronic device having a display section, such as that described in Patent Document 1. This electronic device is illustrated as a highly flexible electronic device that includes a display panel having flexibility, a substrate having flexibility, a battery having flexibility, and so on.

[0003] With reference to FIG. 11 and FIG. 12, the construction of the electronic device of Patent Document 1 will be described.

[0004] FIG. 11(a) is a plan view showing the construction of a flexible electronic device 200 which is described in Patent Document 1 as an electronic device of a first example construction. FIG. 11(b) is a cross-sectional view showing the construction of the flexible electronic device 200 through a flexible display panel 212.

[0005] As shown in FIGS. 11(a) and (b), the flexible electronic device 200 includes a flexible display panel 212 having a flexible driver IC 211 for driving, a flexible printed circuit 213, a flexible driving circuit board 214 (hereinafter simply referred to as the “substrate 214”), a flexible case 216 (hereinafter simply referred to as the “case 216”), and a flexible battery 217.

[0006] FIG. 12 is a plan view showing the construction of the substrate 214 of Patent Document 1. As shown in FIG. 12, a plurality of rigid circuit parts 232 are disposed in a matrix shape on the substrate 214. In a portion of the substrate 214 where no circuit parts 232 are disposed, a plurality of lines of bending *f* extend linearly, such that the substrate 214 is bendable at the lines *f* of bending.

[0007] Thus, since many of its constituent elements have flexibility, the flexible electronic device 200 is supposed to have a high flexibility across the entire device. Furthermore, although each of the plurality of circuit parts 232 disposed on the substrate 214 lacks flexibility, the plurality of circuit parts 232 are disposed in a matrix shape, thus allowing the plurality of lines *f* of bending to extend across the entire substrate, thereby further promoting flexibility.

CITATION LIST

Patent Literature

[0008] [Patent Document 1] Japanese Laid-Open Patent Publication No. 2008-233779

SUMMARY OF INVENTION

Technical Problem

[0009] The flexible electronic device 200 of Patent Document 1 can be flexed at the positions of the lines *f* of bending (i.e., any portion called the “sea” in Patent Document 1);

however, in the portions surrounded by the lines *f* of bending (i.e., portions called the “islands”), the rigid circuit parts 232 hinder sufficient flexibility. Patent Document 1 fails to describe any specific construction and designing scheme for allowing the substrate or the like to be flexed or curved at portions other than the lines *f* of bending. Moreover, Patent Document 1 lacks discussion of any relationship between the level of flexibility required of the flexible electronic device 200 and the thickness of the case 216, the width of the circuit parts 232, and the thickness of the circuit parts 232, thus making it difficult to realize a flexibility that is optimum for an appliance.

[0010] For example, given the same circuit parts 232, flexibility will presumably improve if the thickness of the case 216 is increased. Also presumably, given a constant thickness of the case 216, flexibility will improve if the width and thickness of the circuit parts 232 are reduced. However, increasing the thickness of the case 216 will increase the thickness of the entire appliance, thus resulting in a problem of difficulty of downsizing the appliance. Moreover, it is often difficult to change the sizes of the necessary circuit parts 232, and it is not easy to improve the flexibility of the appliance based on the sizes of the circuit parts 232. Since the limits of flexibility of an appliance are determined by the dimensions of each individual rigid circuit part 232, it is impossible according to principles to improve the flexibility while keeping a constant thickness of the case 216, even if the circuit parts 232 are disposed in island shapes or in a matrix shape.

[0011] The present invention has been made in view of the above problems, and an objective thereof is to provide a highly flexible electronic device or display device by using circuit parts of appropriate sizes, without unnecessarily increasing the device thickness. Another objective of the present invention is to provide an electronic device or display device which reconciles thinness and flexibility with a good balance.

Solution to Problem

[0012] A display device according to the present invention comprises: a display panel having flexibility; a circuit board having flexibility; a circuit part disposed on the circuit board, the circuit part having rigidity; and a housing accommodating the circuit board and supporting the display panel above the circuit board, the housing having flexibility, wherein, the display panel, the circuit board, and the housing have flexibility at least along a first direction which is perpendicular to the plane of the display panel; the housing internally has an upper face and a bottom face, the circuit board being disposed on the bottom face of the housing; and a length *2a* of the circuit part along a second direction which is parallel to the plane of the display panel, a thickness *b* of the circuit part along the first direction, a distance *d* between the bottom face and the upper face of the housing or between the bottom face and a lower face of the display panel, and a radius of curvature *r* of the bottom face of the housing when the housing is curved to a maximum extent along the first direction satisfy the relationship:

$$a \leq [d^2 - b^2 + 2 \cdot r \cdot (d - b)]^{(1/2)}.$$

[0013] In one embodiment, the radius of curvature *r* is a radius of curvature of the bottom face of the housing when the housing is curved so that the upper face of the housing or the lower face of the display panel abuts with the circuit part.